- ***Air Disc Brake Production, Use & Performance:***

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Air Disc Brake Production & Usage

Air Disc Brake History

- 1981: First North American Air Disc Brake Released
- June 1988: Air Disc Brake Standard Equipment on European Renault R420 4 x 2 High Cab-Over Tractor
- 1990: First All Wheel Air Brakes on Mercedes Benz 0404 Coach
- 1994: First North American All Wheel ADB Standard Equipment on MCI Renaissance Long Distance Coach
- 2001: Over 1.5 Million Air Disc Brakes Produced in Europe

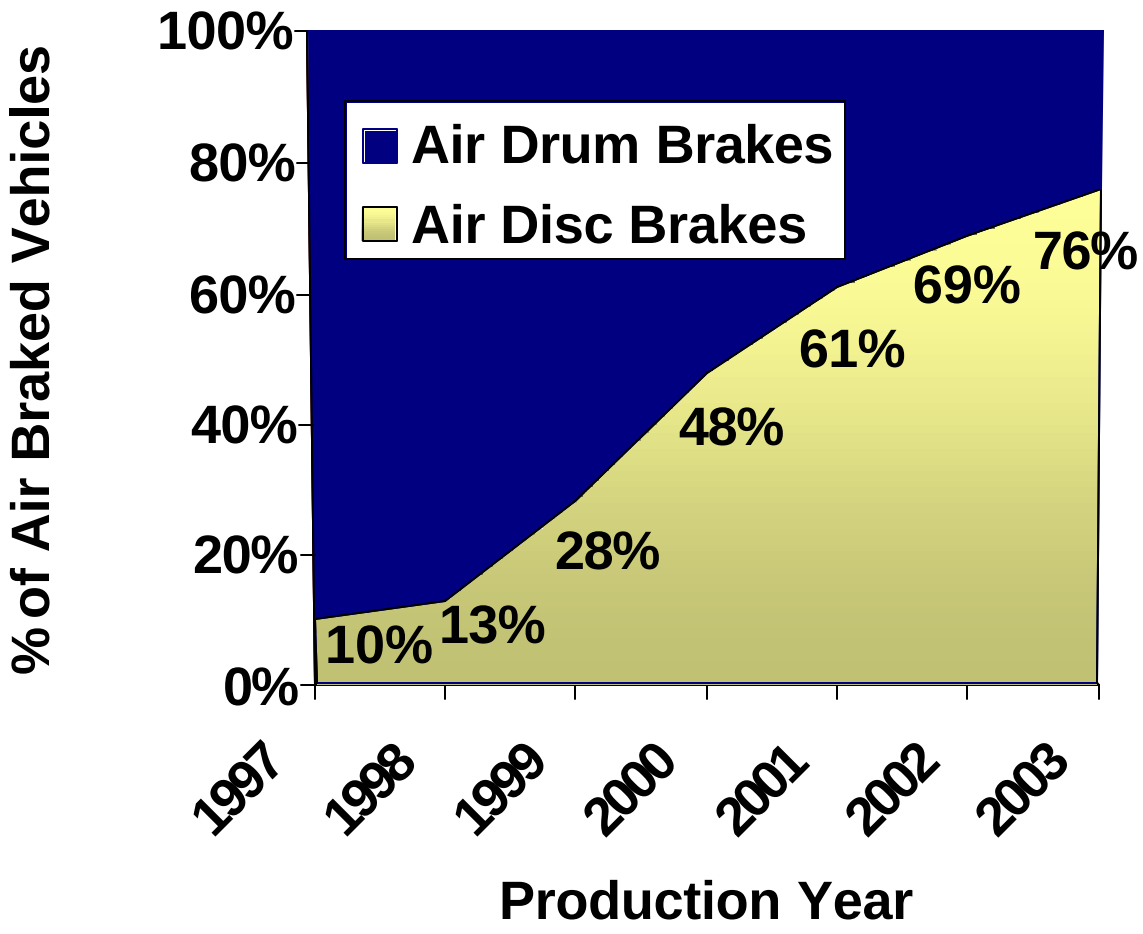
Over 200,000 Air Disc Brakes Sold in U.S.

Current Customer Base

- Fire & Emergency Rescue
  - Spartan Motors
  - Sutphen
  - E1
  - Pierce
  - FWD/Seagrave
- Motor Homes
  - Foretravel
  - Monaco Coach
- Intercity Coach
  - MCI
  - Prevost

Used Extensively on Specialty Vehicles
Where Duty Cycles Warrant Air Disc Brakes

European Drum to Air Disc Migration



Why Air Disc Brakes in Europe?

- Cost
  - Lower cost than IN-HOUSE drum brakes
- Cost of Ownership
  - Faster servicing, less unscheduled stops
- Improved Stability
  - High front axle loadings compared with N.A.
- Improved Braking Performance
  - Shorter Stopping Distances
- Electronic Braking Systems
  - Improved stopping distance and compatibility with sensing systems.

Market Differences

Europe

- **Have Outsourced ADBs to Replace Their Heavy, Expensive Drum Brakes**
- **Disc Brakes Cost Comparable to Drum Brakes**
- **Spec'ing is Non-Existent**
- **Have Made Air Disc Brakes Standard**

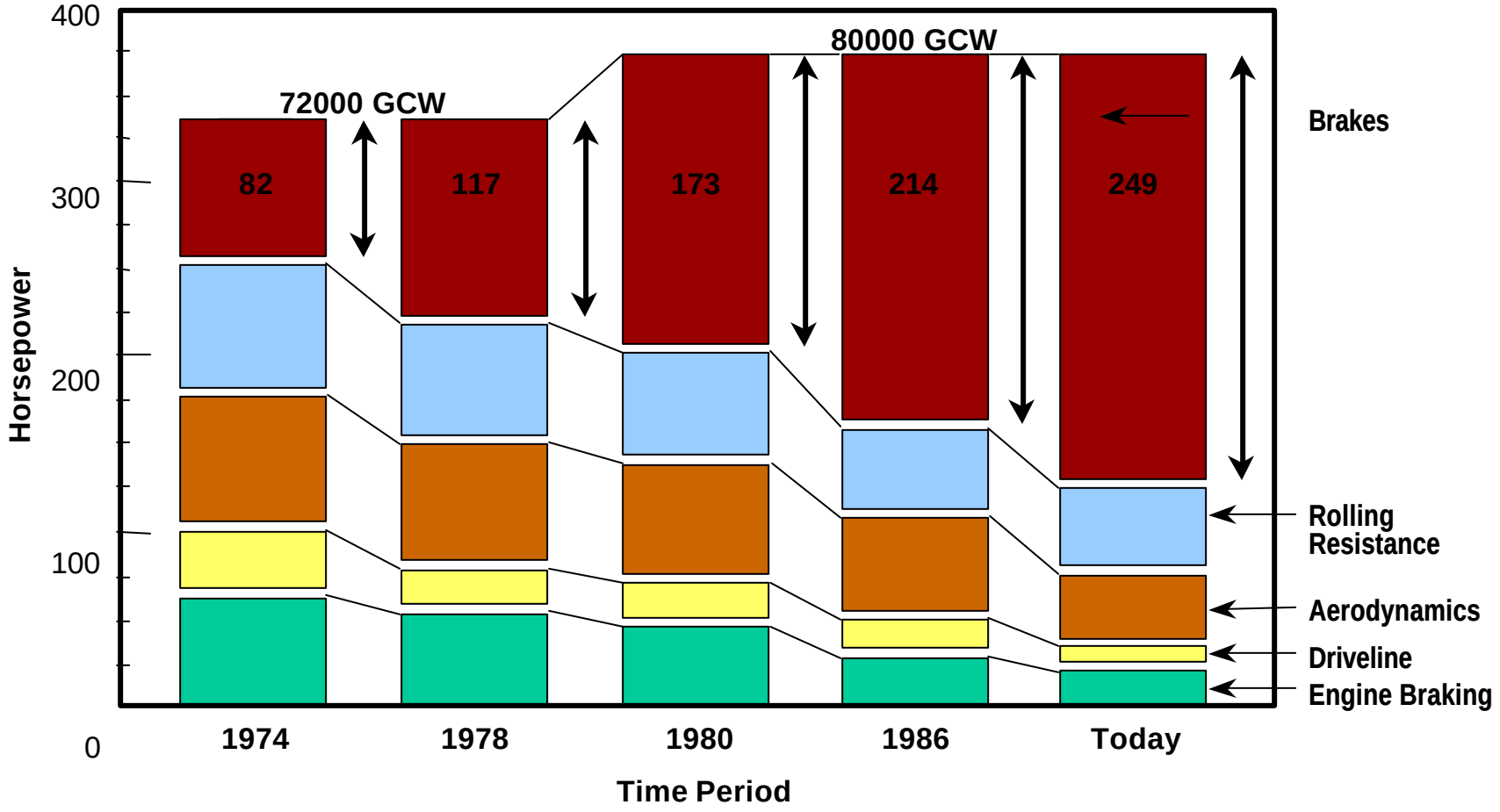
North America

- **Evolving Standard in Niche Applications**
- **Currently Buy Cam Brakes at About One-Half the Cost of Air Disc Brakes**

Heavy Truck Retardation Capability

Typical U.S. 5 Axle Tractor / Trailer Combination

at 50 mph on 3.5% Downhill Grade



NHTSA / DOT Initiatives

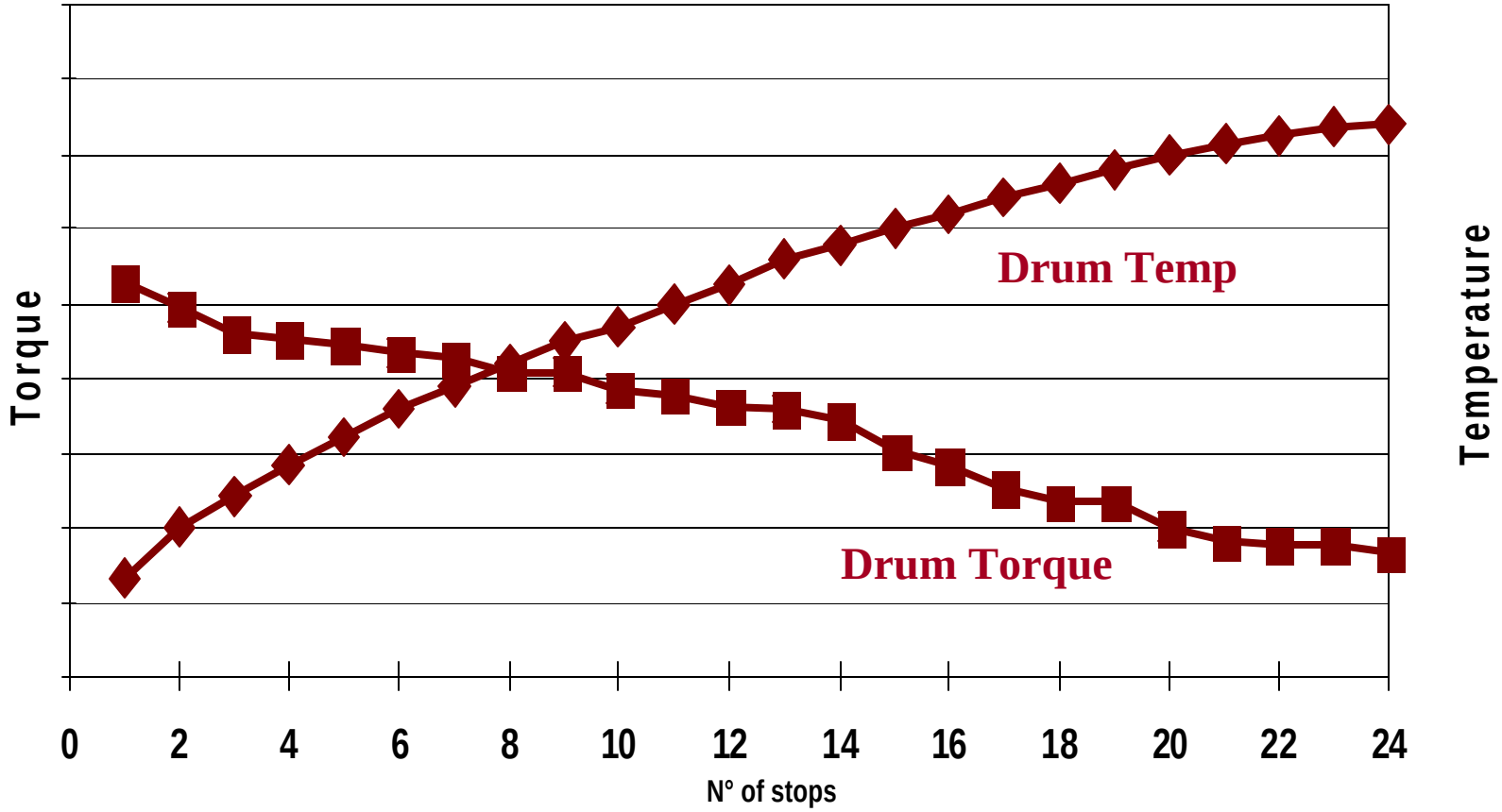
- Objective: Cut heavy truck related fatalities in half by 2010
- Reduce Heavy Truck Stopping Distance Requirement by 30%
  - Already Demonstrated by Many Trucks
  - Increased Front Brake Torque
  - ECBS (as an Enabler)
- Coordinated Effort with the Heavy Truck Industry
  - NHTSA 9-Step Program
  - Evaluate Maintenance & Reliability History through the **Intelligent Vehicle Initiative**

Drum Brake Improvements

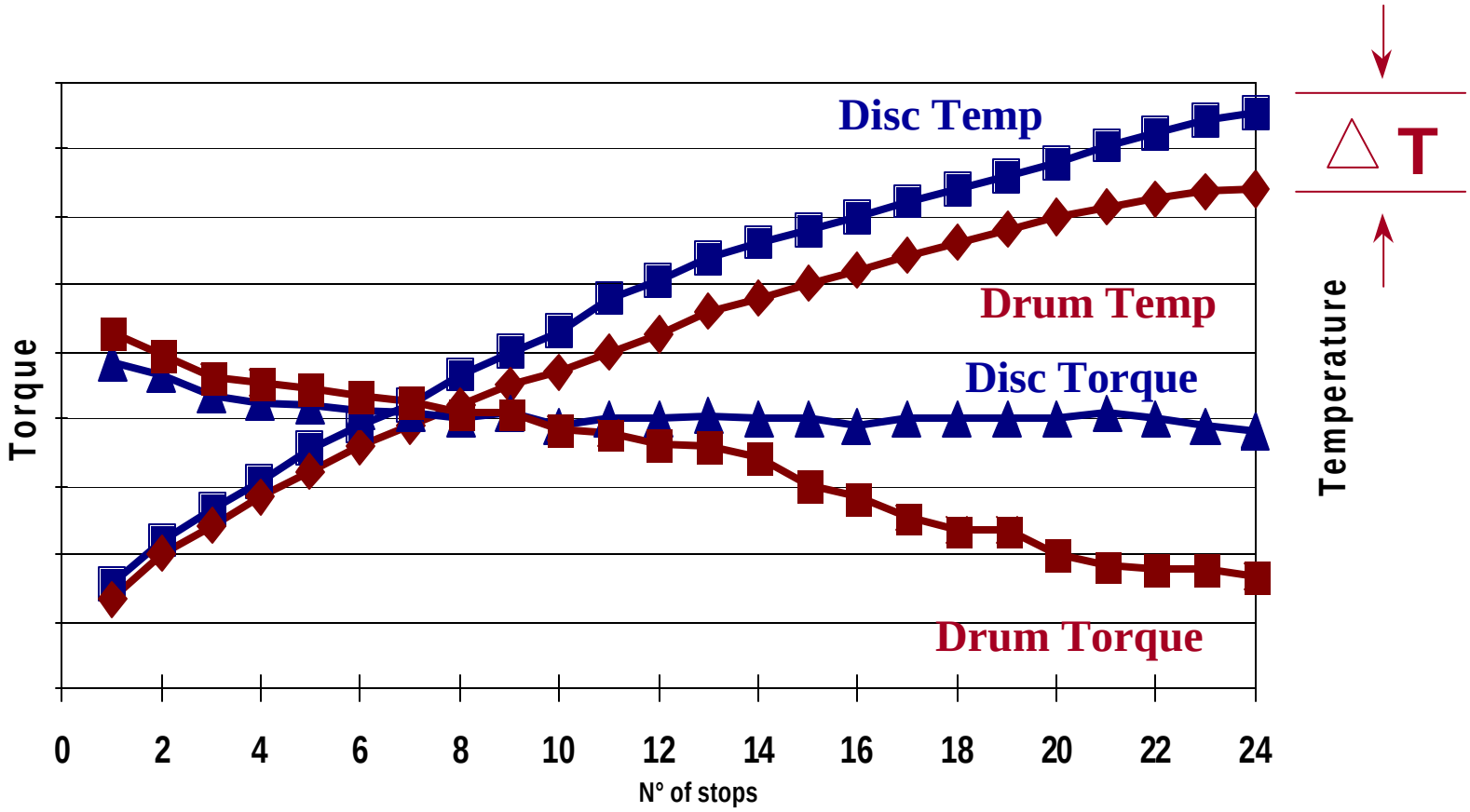
- There Have Been Many Improvements to Foundation Drum Brakes
  - Extended Maintenance
  - Better Automatic Adjustment
  - New Lining Formulations for Better Life
- Disc Brakes Still Provide the Best Retardation Performance

Air Disc Brake Technological Attributes & Performance

Temperature and Fade
Drum Brakes

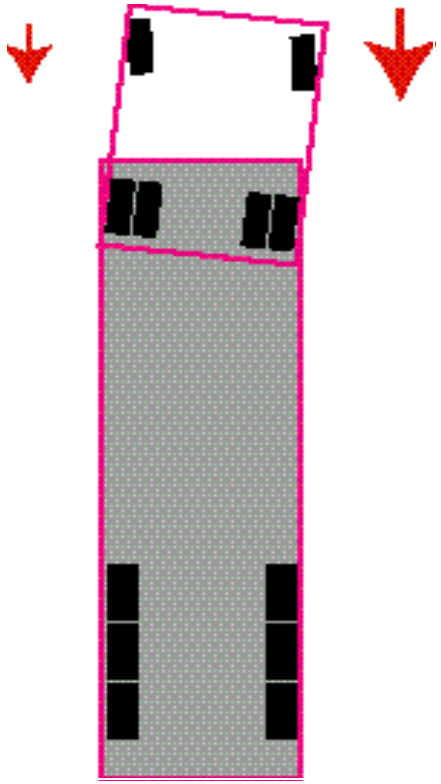


Temperature and Fade
Drum vs Disc



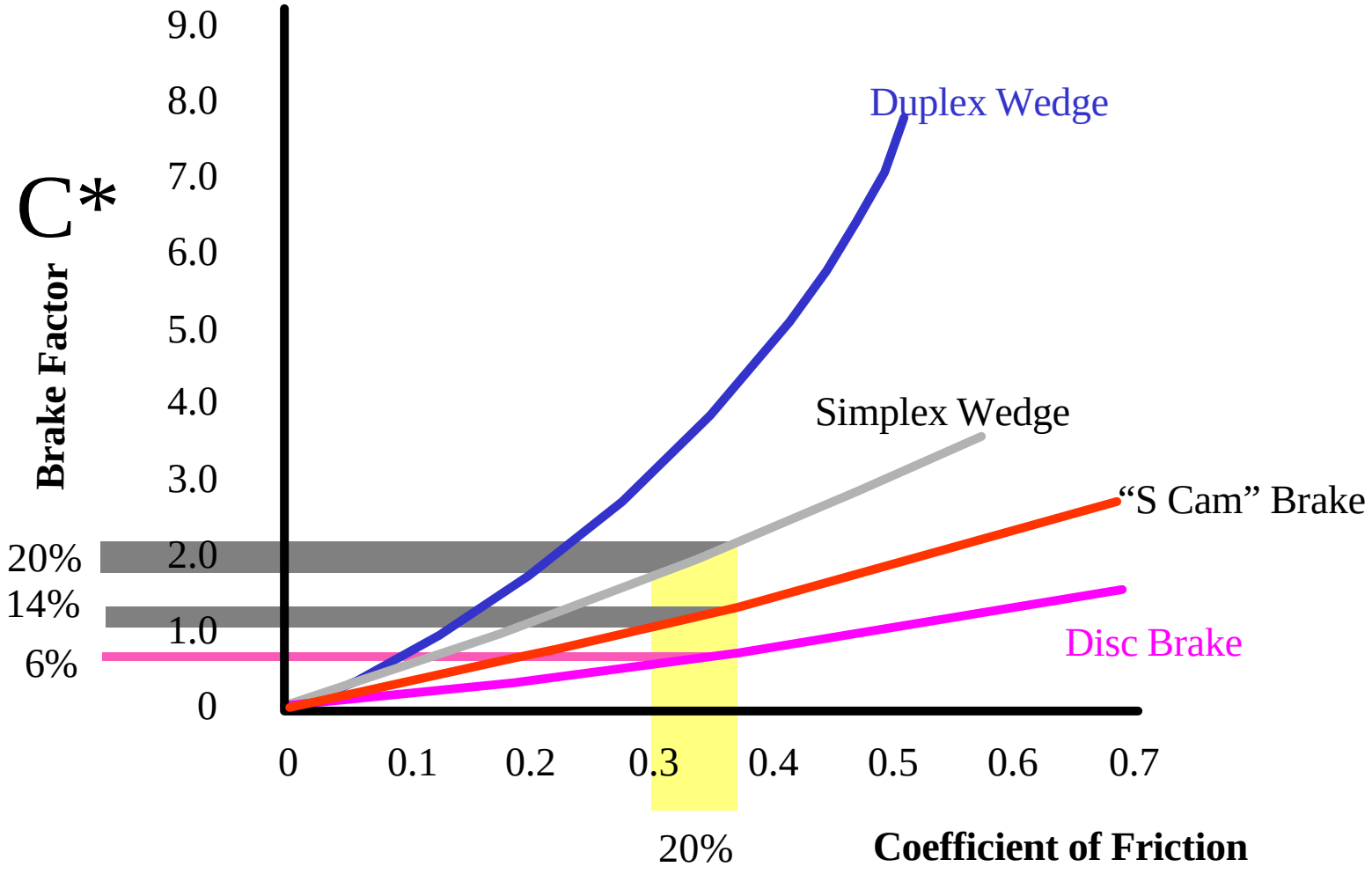
Stability

- Brake Pull is Caused by Uneven Braking Torques Developed Between LH and RH Brakes
- Drum Brakes Have Built-in Mechanical Advantage (Brake Factor) Due to Self Energization of the Leading Shoe(s)
- Unequal Torque Is the Result of Variation in the Self Energization As a Result of Friction Level Variation Due to Fade



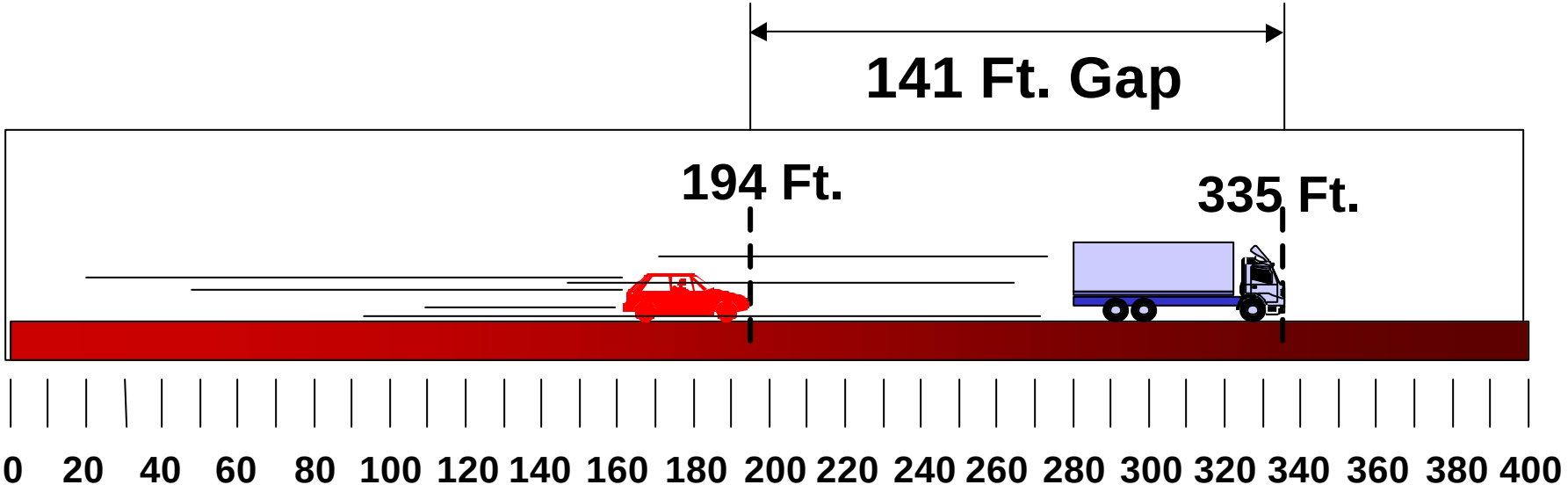
Problem is Proportional to Brake Factor

Brake Factor vs. Friction



Stopping Distance Comparison

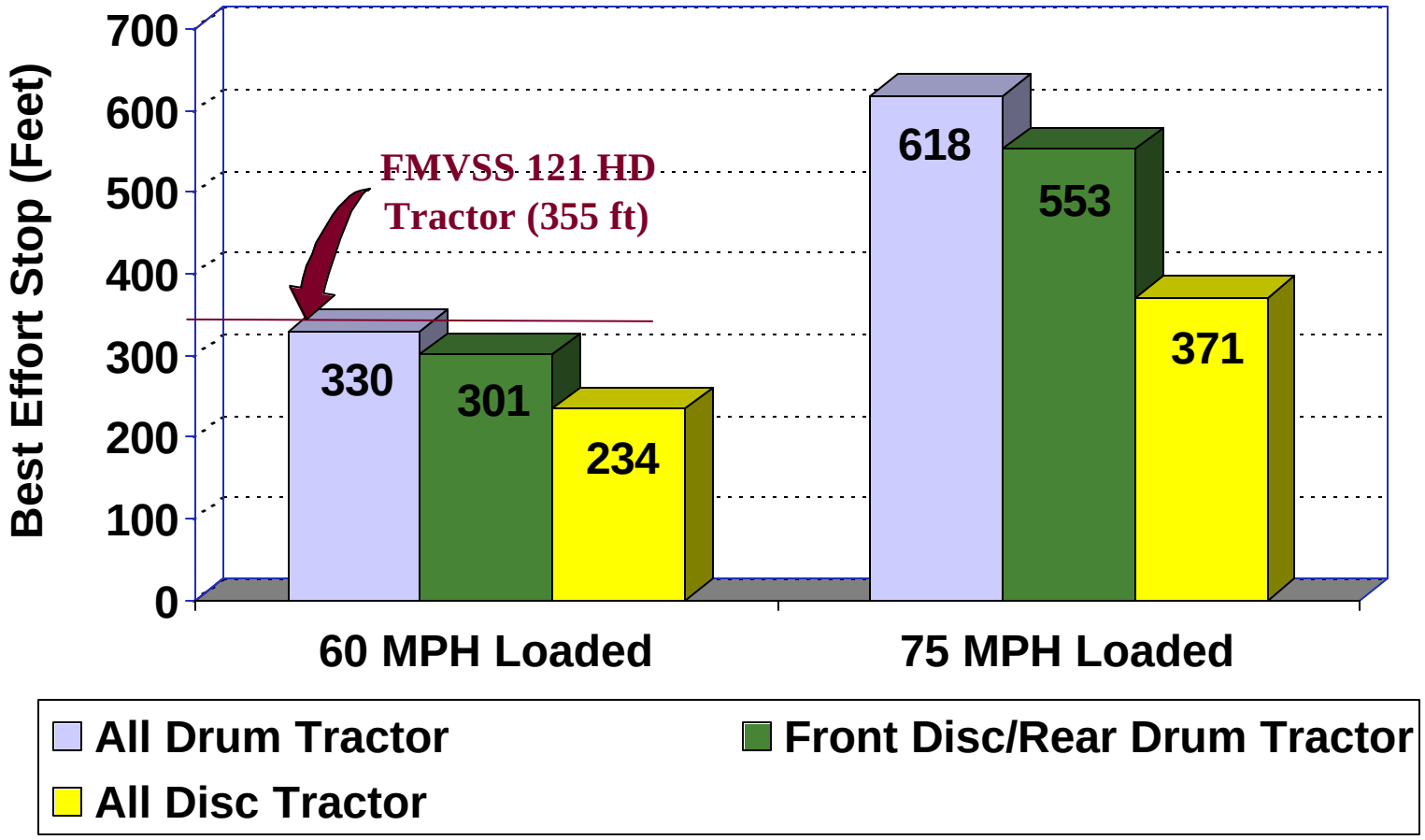
Trucks vs. Passenger Cars



NHTSA Working with Industry to Reduce Gap

Tractor Stopping Distances

Disc vs. Current Drum Brake



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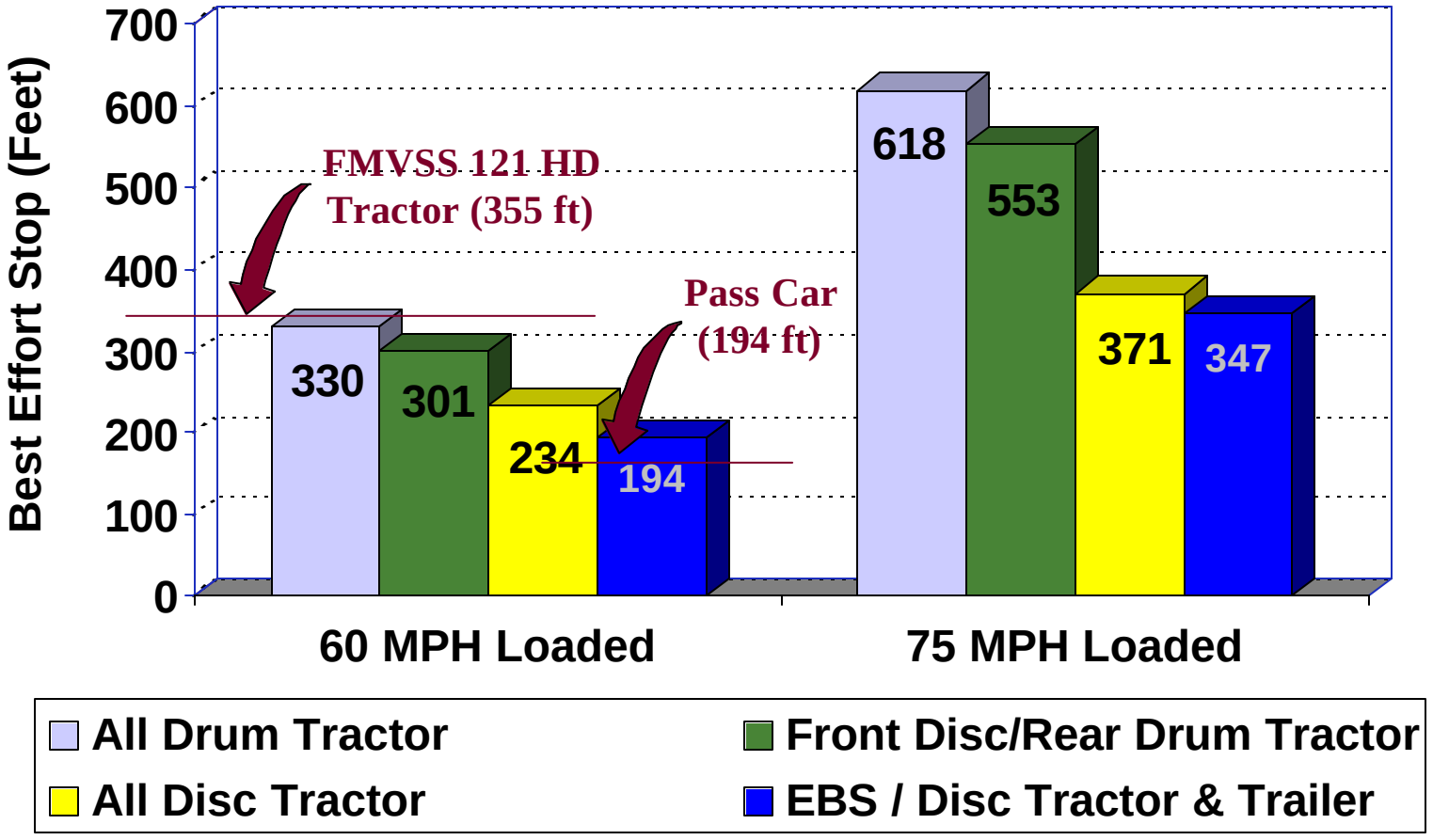
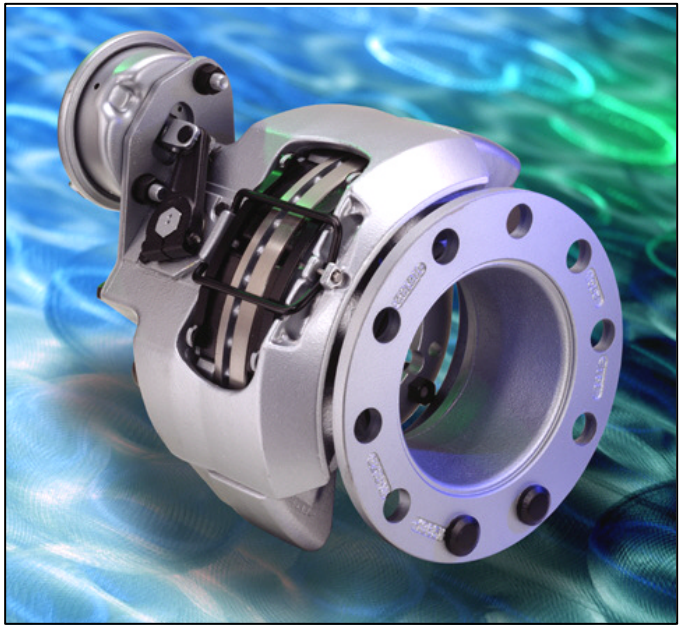
Disc vs. Current Drum Brake



Production, Use & Performance Summary

- European Standard
- Niche U.S. Applications
- Improved Stability & Fade-Resistance
- Shorter Stopping Distances



- Superior Stopping Capability at Higher Vehicle Speeds
- NHTSA / DOT Currently Evaluating